

Engineering Teacher Education: Exploring Elementary Teacher Learning in an Online Certificate Program for In-Service Educators in Engineering.

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Natalie De Lucca is a Ph.D. student in the Mathematics and Science Education specialization in the Learning, Teaching, and Diversity program at Vanderbilt University. Natalie's research aims to complicate optimism surrounding K-12 engineering curricular integration as a mechanism for educational equity. With a B.S. in engineering and as a former high school physics and engineering teacher, she is interested in how engineering disciplinary learning surfaces the sociohistorical context of schooling. Her work studying K-12 engineering learning and teaching explores connections between classroom-level interactions and broader social structures and systems.

Exploring K-12 teacher learning in an online engineering education graduate certificate program (NSF DRK12 Project)

Abstract

Developing Teacher Noticing in Engineering in an Online Professional Development Program is an NSF DRK12 project that studies how K-12 teacher learning in engineering unfolds in an online graduate certificate program. The project is focused on understanding how online learning structures help develop teachers' abilities to notice students' engineering thinking. However, as the project has unfolded research has expanded to other areas of investigation. This paper and associated poster shares a summary of the project's work to date.

Introduction

In 2015 Tufts Center for Engineering Education and Outreach developed an online graduate-level certificate program in engineering education in response to the Framework for K-12 Science Education [1] and Next Generation Science Standards [2] call for teachers to include more engineering in their classrooms. Drawing on research in teacher education e.g. [3]–[7], The Teacher Engineering Education Program (TEEP) was designed to develop both teachers' engineering content knowledge as well as their pedagogical resources for teaching engineering. TEEP (teep.tufts.edu) is an intensive 18-month program (Figure 1) where participants take two engineering content courses and two engineering pedagogy courses.

Fall 1	Spring 1	Summer 1	Fall 2
<i>Content Course 1</i>	<i>Pedagogy Course 1</i>	<i>Content Course 2</i>	<i>Pedagogy Course 2</i>

Figure 1: The TEEP online graduate certificate program has a 4-course, teaching-level specific, sequence.

All TEEP courses are asynchronous and use a combination of reading and hands-on assignments as well as discussions to meet learning goals. Using a cohort model, TEEP participants move through the courses as a group building community and collaborations.

Beginning in 2017, with support from an NSF DRK-12 award, the first and second authors of this paper began a research study to investigate how the online program interacted with teacher learning. Focusing on TEEP program participants who taught at the elementary level (K-5), the study collected data using multiple interviews, teachers' own video recording of their classes and the participating teachers' coursework. The data collection has followed two cohorts of teachers (N=26) through their 18-month progression.

Research Areas and Findings

- Teacher learning in online video discussions of student thinking in engineering – The project used an online video annotation tool to engage participants in learning to attend to students' engineering thinking. We went on to analyze teachers' comments on four videos of students' engineering –two from early in the first pedagogy course and two from the end and found shifts in how teacher interpreted student thinking. [8], [9]

- Investigating shifts in teachers' pedagogical reasoning and practices in engineering -To explore: What stances do teachers take toward learning and teaching engineering design? We identified two teachers, Alma and Margaret, who exhibited different transformations over the 18-month program. Drawing on six interviews and three videos of their teaching, we developed case studies characterizing their stances toward teaching and learning engineering.[10]
- Meaningful engineering in teachers' engineering education - One of the conjectures employed in the design of the online engineering program for teachers was that engaging participants in engineering tasks that were genuinely challenging for them as adults would support progress and sophistication in their understanding of engineering. For this component of research, analysis used coursework and interviews to examine how teachers' experience with engineering shifted their understanding of engineering as well as their epistemic empathy for students. [11], [12]
- Humanizing teachers' relationships to discipline of engineering – Project research has also attended to how teachers make sense of their relationship with engineering. In a case study, we examine how one teacher made connections between her engagement in doing engineering herself and her personal and professional lives. In our analysis, we first show how Alma shifted in her participation in the engineering design process (EDP), from treating it at first as a set of explicit steps to using it as a tool to help her think more responsively about how to solve design problems. [13]
- Ideological discourses and engineering epistemologies as resources for teacher reasoning To understand engineering's potential opportunities to support equitable classroom learning experiences, we have begun to explore the resources teachers use to make sense of student capability. Our recent work begins to explore engineering epistemologies and ideological discourses as resources for teachers' reasoning about their students' ability, identifying patterns in the ways these resources interact.[14]

Dissemination

The project is also working on making select case studies from the project available for other teacher educators focused on engineering education.

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